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^{99M}TC- DIETHYLENE TRIAMINE PENTACAETIC ACID RENAL SCINTIGRAPHY: EVALUATION OF URINARY TRACT OBSTRUCTION

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ABSTRACT

Most chronic nephropathies are characterized by a progressive course that leads, to loss of kidney function and the need for renal replacement therapy.

P**urpose of Study:** To evaluate the 99mTc-DTPA dynamic renal scan in urinary tract obstruction with a special gamma camera. The images obtained were helped in the diagnosis and treatment of certain kidney diseases such as; renal failure or chronic renal failure, obstruction in their urine collection systems, renal and a kidney transplant. Studies were performed to determine the rate at which the kidneys are filtering a patient's blood.

Materials & Methods: These studies used 99mTechnetium DTPA (99mTc-DTPA) intravenously. This radiopharmaceutical identifies obstruction (blockage) in the collecting system.

Results: Patients of renal diseases underwent diuretic 99mTc DTPA scanning at the time of diagnosis and at yearly intervals thereafter. Clinical follow-up (long-term) was 2 years. In this study we have examined a total of 47 patients. Normal study was seen in 30/47[63.82%] patients. Abnormal study 17/47[36.17%] or obstructed uropathy were observed.

Conclusions: 99mTc-DTPA Renal scintigraphy Camera is a noninvasive procedure. This gives valuable information like glomerular filtration rate, differential renal functions and level of obstruction which help physicians and surgeons in the patient's management.

KEYWORDS: 99mtc-DTPA, Renal Scintigraphy, Gamma Camera, Urinary Tract Obstruction

INTRODUCTION

^{99m}Technetium- diethylene triamine penta-acetic acid (DTPA) is excreted predominantly by glomerular filtration and used to measure GFR. Excretion by the kidneys is significantly affected by reduced renal function. This radiopharmaceutical is also used to assess renal blood flow and function, renal allografts, renovascular hypertension, and obstructive uropathy. Clinically renal sintigraphy is indicated for detection, evaluation, and/or quantification of renal function, urinary tract obstruction, renovascular hypertension, pyelonephritis, renal allografts, parameters of renal function, including effective renal plasma flow (ERPF), glomerular filtration rate,(GFR), and differential (also known as split or relative) renal function. Glomerular radiopharmaceuticals (DTPA) mainly cleared by glomerular filtration. For dynamic renal scintigraphy, administered activity of up to 15 millicuries (555 MBq) may be given to adults. For children it should be determined based on body weight and should be as low as reasonably achievable for diagnostic image quality,

typically in the range of 0.1 to 0.2 millicurie (3.7 to 7.4 MBq) per kilogram, with a minimum of 1.0 millicurie (37 MBq) and a maximum of 5.0 millicuries ((185 MBq).[1] Radionuclide renography refers to serial imaging after intravenous administration of technetium-99m DTPA. It is used for qualitative and quantitative evaluation of differential renal function. Commonly used technique involves dynamic acquisition of 1-2 second images for 1 minute (vascular phase), followed by 15-60 second images for 20 to 30 minutes (uptake, cortical transit, and excretory phases).

The regions of interest are typically drawn around the kidneys as well as in background region adjacent to each kidney. The differential renal function is calculated based on the relative counts accumulated in each kidney during the second minute after injection of the radiopharmaceutical. Diuretic renal scintigraphy is performed to differentiate non-obstructed kidney from urodynamically obstructed kidney. It is also useful after corrective renal surgery for assessing functions and urodynamics. DTPA and acquisition of dynamic 15-60 second posterior renal images for 20 to 30 minutes [2, 3]. Furosemide, 0.5 mg/kg (1 mg/kg for children) was then intravenously administered, and dynamic 15-60 second renal images are obtained for another 20 to 30 minutes (F+20). Other techniques include administering furosemide 15 minutes prior to (F-15) or at the time of (F0) radiopharmaceutical administration. The initial set of images is used for evaluating differential renal function. The images obtained after administration of furosemide are used for quantitative analysis of post-diuresis clearance of the radiopharmaceutical from the dilated collecting systems. Diuresis renography is usually performed with the patient in the supine position. This may cause delayed clearance of the tracer from some dilated but nonobstructed collecting systems. Therefore, an additional posterior static image after the patient has been in an upright position for 10 to 15 minutes will help to assess gravity-assisted clearance.

In cases of renovascular hypertension which is caused by hemodynamically significant stenosis of the renal artery or one of its branches. However; renal artery stenosis may be present but not be the etiology of the patient’s hypertension. Therefore, the goal of renal scintigraphy in the evaluation of hypertensive patients is to identify those who have renal artery stenosis with associated renin-dependent hypertension and would benefit from revascularization. In the presence of hemodynamically significant renal artery stenosis, renal perfusion pressure is reduced. Because of this auto regulatory mechanism, the GFR is maintained and conventional renal scintigraphy may be normal. In these patients, blockade of the conversion of angiotensin I to angiotensin II by administering angiotensin converting enzyme (ACE) inhibitors causes dilatation of the efferent arterioles. This leads to reversible decrease in GFR that is detectable on renal scan.

MATERIALS & METHODS

The patients were well hydrated before the scan. The radionuclide 99mTc has ideal physical characteristics to use in radiation medicine. It has a short half-life (6 hours) and suitable radiation characteristics (140 keV photons in 90% abundance and no beta radiation). The 140 keV photon has adequate tissue penetration and is efficiently measured by the gamma camera. Its low radiation dose permits repeated examinations in children. Freeze dried DTPA kit (TCK□7) procured from board of radiation and isotope technology was labeled by adding 50□60 mCi in 3□4 ml of Technetium□99m sodium pertechnetate following manufacturer’s protocol. Planar gamma camera (ECIL, India) fitted with low energy all purpose (LEAP) collimator was used to measure GFR of all the patients. The patients were positioned on a comfortable scanning bed and a small dose of Tc-99m DPTA was given intravenously through the cannula. Imaging of the urinary tract (kidney, ureters and bladder) was then performed over the next 30 minutes using a gamma camera (electronic Corporation of India Limited).The study was carried out at the nuclear medicine, Gandhi medical college, Bhopal, India. All the data of patients in the present retrospective study was collected from nuclear medicine

record room data and the value of GFR by gamma camera. We performed routine 99mTc-DTPA study in 47 patients in the dose of 5-10mCi in children and 15-20mCi in adults in patients of urinary tract problems.

Image Acquisition

The gamma camera was peaked on 140 keV, with a 20% window. Collimator, low energy high resolution was used. Patient position, all images were obtained from the posterior. The patient was made comfortable in a supine position. The posterior dynamic study was performed and also the bladder was included in the field of view.

Computer Acquisition

In all patients, a 20-second frame rate was used. For first-pass studies, 1 frame/second for 30 or 40 seconds was recorded. The normal time for a dynamic study was 20 minutes. IV injection of diuretic- Frusemide (Lexis) injected during acquisition.

Imaging Interpretation

The blood flow phase was analyzed predominantly qualitatively using the aorta. Mildly, moderately and severely decreased flow was considered as so according to the severity of the flow reduction on the visual analysis as well. Interpretation of the functional phase was performed by evaluating the renogram curves, qualitatively and quantitatively.

Imaging Study

Dynamic renal scintigraphy studies were obtained using the rapidly excreted radiopharmaceuticals. Dynamic studies start by rapid acquisition of image frames upon injection of the tracer to follow activity while passing through the blood vessels till reaching the kidneys to evaluate the blood flow. This phase was followed by another series of imaging frames every 10–20 s of the kidney to evaluate the kidney functional handling of the radiotracer. The computer processed to generate time–activity curve (renogram) for both kidneys to show the uptake, build up, and excretion of the 99mTc-DTPA by each kidney and the % contribution of the kidneys to the total renal function (split or differential renal function) was generated.

After IV administration of tracer, the compound is excreted by the kidneys and its progress through the renal system was tracked with an ECIL Gamma camera. When there is no blood flow, kidney will not be visualized. If the kidney receives blood, but there is an obstruction inferior to the kidney, the tracer will not pass beyond the level of the obstruction, whereas if partial obstruction is present, then there will be delayed transit time for the DTPA to pass. The time activity curves provide more information; with normal kidney perfusion, peak activity must be observed after 3–5 minutes. Differential function between each kidney's filtration activities was calculated with the relative quantitative information.

Captopril (ACE Inhibitor) Renography (Two Days Study)

Technetium-99m DTPA is used. Renal scintigraphy is performed approximately 1 hour after oral administration of 25 to 50 milligrams of captopril or 10 to 20 minutes.

The scintigraphy study involved two steps;

- Baseline renal scintigraphy(BS):Posterior images were acquired with single head ECIL gamma camera equipped with LEAP collimator.10mCi 99mTc-DTPA was injected by IV route followed by rapid acquisition in the dynamic mode.

- Captopril renal scintigraphy (CS): Oral captopril (50mg) 1hour before the acquisition was given to patients. The scintigraphic images of the kidney were obtained.

RESULTS

In this study we aimed to determine the need for 99mTc-DTPA in the management in our large patient group patients. Diuretic scintigraphy is an effective diagnostic modality for early detection of urinary tract obstruction and abnormalities of parenchymal functions. The present study comprises of a total number of 47 patients underwent 99mTc-DTPA diuretic renal scintigraphy for evaluation of urinary tract obstruction and functions with the age range of 3 months to 70 years of male and females. Each pt's were evaluated for its anatomy, physiology, functions, hydronephrosis and drainage patterns whether obstructed or non-obstructed. DTPA scan reveals a change in function for example obstruction or a poorly functioning kidney. Total number of patients was 47. There was 2/47(4.25%) had renal artery stenosis and 1/47 (2.12%) had horse shoe shaped kidney. Normal study was seen in 30/47[63.82%] patients. Abnormal study 17/47[36.17%] or obstructed uropathy were observed. In 10/47 [21.27%] patients were found obstruction with 99mTc-DTPA plus lasix and 7/47 [14.89%] patients were interpreted as non obstructed 99mTc-DTPA plus lasix renal scan.

In patients of renovascular hypertension, we observed by 99tc-DTPA (CS) a dramatic reduction of renal perfusion and cortical uptake in the upper and mid pole of affected kidney, and the presence of renal artery stenosis was confirmed. In our study, renal damage was observed on the bases of severity and duration of obstruction. Functions were assessed with the help of scintigraphy images, time activity curves/ renogram (arterial blood flow, renal perfusion, cortical uptake and excretion) curves of each kidney, whether normal, obstructed or non-obstructed. There were no false negative results.

DISCUSSIONS

Differential renal function assessment using 99mTc-DTPA was carried out in 12 children aged between 3 weeks and 11 years who had undergone surgical procedures which allowed separate access to the urine output. We conclude that the method is accurate and recommend its use in the management and follow-up of patients with asymmetric renal disease [4]. In this study, we summarized that radionuclide method for evaluation of renal functions is important in renal disease of children. There are three most common radio-pharmaceutical used, Tc99m-MAG3 (Mercaptoacetyltriglycine) and Tc99m-DTPA (Diethylene Triamine Pentacaetic Acid) and 99mTc-EC (Ethyl Cysteine). MAG-3 is a best diagnostic radiopharmaceutical than Tc-99m-DTPA, particularly in newly born babies with impaired function, and in patients of suspected obstruction. DTPA is the second most commonly used renal agent, because it is the least expensive and easily available. Tc-99m-DTPA is filtered by the glomerulus and used to measure the glomerular filtration rate (GFR). The extraction fraction of DTPA is approximately 20%, less than half that of MAG3 [5]. However, EC is preferred when the serum creatinine is high. In this study we found 99mTc-DTPA renal scintigraphy is safe, accurate and very sensitive in adult and pediatric patients. Captopril (an angiotensin converting enzyme inhibitor drug) has also been used to detect the cause of hypertension in patients with renal failure [6, 7, 8], to identify reduced renal function and to identify renal artery stenosis[9]. In our research study, there were 2 patients of renal artery stenosis diagnosed with captopril induced renal scintigraphy. This study show better quality images regardless of the level of renal function, and with the benefit of being able to administer lower radiation dosages.

We have shown that assessment of individual renal function with 99mTc-DTPA in children is accurate. It carries

less risk and is no more disturbing to the child than a comparable radiological investigation. It can be done in any hospital with a modern nuclear medicine department. We believe that the use of this technique will prove to be important in the management and follow-up of patients with asymmetric renal diseases and also in the understanding of the evolution of these disorders.

CONCLUSIONS

99mTc-DTPA dynamic renal scintigraphy is a noninvasive procedure plays a very important role, provides evaluation of renal functions and predicts patho-physiology. It is still a rapid increase in the scope and number of radionuclide renal studies. It is instrumental in the diagnosis and follow-ups of urine outflow obstruction in adults and more importantly in children. It also helps in the detection and more importantly follow-up of vesicoureteral reflux and evaluation of renal transplantation and its complications. Captopril renal scintigraphy is a very sensitive method for the diagnosis of renal artery stenosis.

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CONFLICTS OF INTERESTS

This is a routine clinical nuclear medicine and scientific research work of our hospital of Gandhi Medical College, Bhopal, India. Authors declare no conflicts of interests.

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